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American Beef and Nuclear Power Plants: Risk Management of Complex Technological Systems and the Precautionary Principle[(1)]

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Abstract

Man-made disasters, unlike natural disasters such as typhoons, are in principle avoidable. Risk-management in practice however is extremely difficult to do. The difficulty arises not just from the interwoven complexity of technological systems involved, but also from the intrinsic uncertainty of its target, that is the risk itself. I shall examine two cases of risk-management in South Korea, the one related to American beef and the other related to nuclear power plants. The first is a case of dramatically failure, and the other, of continued interactions between multiple interests groups. I shall argue that a successful and democratically justified risk-management of science-technology systems around us should start from their essentially Janus-faced nature. The unpredictability of technological consequences requires us to be even more cautions as regards calculating the ‘expected’ utilities and costs of a complex technological system. The implications of precautionary principle shall also be discussed.

1. Introduction

Man-made disasters, unlike natural disasters such as typhoons, are, in principle, avoidable. We could be more prepared: building better walls, driving more safely, and educating people better. Theoretically, we might consider every possible disastrous scenario which might happen in our complex society, even on an international level, and set up precautionary or pre-emptive measures to prevent the possibility of disasters or, if that is unrealistic, to minimize the expected damages.

We could be even more systematic in our preparing efforts. We could collect the relevant statistics regarding various sorts of man-made disasters and estimate their probabilities. Similarly, we could determine the average costs required to prevent the disasters, and calculate the benefits we could reasonably expect to harvest from our precautionary measures. Based on all this information, we could systemize our decisions to execute (or not execute) certain measures to forestall unwelcome events, and designate how much of our limited resources should be allocated to fund such measures. If the benefits outweigh the corresponding costs, we would be justified in employing some portion of our limited resources (which could have been used for other “utility-raising” activities) to execute the precautionary measures. This is the basic model of cost-benefit analysis, usually regarded by policy makers and public servants as the “golden standard” for public decision-making. On the surface, this model appears clear and simple: you implement the policy as long as the expected utility which is benefit minus cost is positive.

In practice, however, risk management is extremely difficult to do. The difficulty arises not only from the interwoven complexity of the technological systems involved, but also from the intrinsic uncertainty of the risk itself. The first kind of difficulty is more mundane (and therefore much more common than usually assumed), but critical in the sense that the complexity of man-made systems can (and does) often frustrate our efforts to fully understand their working principles and come up with effective preemptive solutions to potentially fatal disasters.

The second kind of difficulty is no easier to deal with. The nature of risk can be vague or uncertain. It can be vague in the sense that the exact content of the risk (if not its consequential manifestation) may be partially socially constructed. More and more children are now diagnosed with ADHD. Although their inattentive behavior and hyperactivity is genuine, the very classification of these children as ADHD patients is a social construct that was only made possible through social negotiation between doctors, health care officials, parents, and other related sectors of society. Under different (more permissive or more negligent, depending on your value-judgment) circumstances, some (not all) ADHD children would have been regarded as just noisy, curious kids, typical for their age. When we start to look at a "normal" child-development process with stricter standards for behavioral characteristics, we are able to invent a new category of disease and its associated risks.(2)

When the risk itself is a social construct to some extent, an effective measure to forestall it must contain social restructuring and negotiations, and this is easier said than done. One cannot simply add some intricate control system to the risky technological system and expect it to take care of all the associated risks. Social institutions and negotiation protocols must be installed to continuously redefine acceptable levels of risk, and legitimate methods for dealing with risk must be determined. Further, the question remains as to whether it is really worth trying to manage risks rather than simply dropping the system entirely. As we will see in the following sections, these issues do arise in risk-management in action, despite official efforts to limit the issues to purely technical matters. The pragmatic considerations are unavoidable.

Risk itself can be indeterminate in the sense that we do not have sufficient statistics to determine economically rational policies that deal with potential disasters. The necessary probabilities might be missing due to either our epistemic limits or to the intrinsically uncertain nature of disasters.(3) Under these circumstances, we can no longer rely on the clear-cut answers of cost-benefit analysis. We have to combine a number of heterogeneous factors, including explicit value judgment, to arrive at a social consensus. Politics in its original sense of "science of government" is badly needed here.

I shall examine two cases of risk management in South Korea, one related to American beef and the other, nuclear power plants. The first is a case of dramatic failure, and the other of continued interactions between multiple interests groups. I shall argue that successful and democratically justified risk management of science-technology systems should start from their essentially Janus-faced nature. The unpredictability of technological consequences requires us to be even more cautious when it comes to calculating the expected utilities and costs of a complex technological system. The implications of the precautionary principle will also be discussed, especially in the context of national and international responses to global warming and climate change.

2. The American Beef Crisis and the Failure of the Deficit Model

In 2008, a very unusual public movement took place in South Korea. A public demonstration was organized to protest the unclear dealings of the Korean government with regard to the import of American beef. The risk of BSE (Bovine Spongiform Encephalopathy, a.k.a. "mad cow disease") was called into question by civil sectors with the support of scientific experts, and the Korean government, backed by their own scientists, vehemently denied the existence of any risk. The public demonstration, (accompanied by candles distributed by volunteers) mobilized a hundred thousand citizens across the country (see Figure 1).

The so-called "American beef crisis" and its associated Candlelight Demonstration have multiple aspects and actors including international risk-governance regimes such as OIE (Office International Des Epizooties), and to discuss them all here is not my intention.(4) I am going to focus on one prominent event involving the dramatic failure of an old-fashioned model of science communication: the deficit model.

Korean government officials and their supporting scientists emphatically asserted from the very start that American beef was "safe from BSE." Later, when challenged, they retreated to the more defensible position that the health risk of American beef associated with BSE was extremely low, low enough to be rationally ignored. This transition from the simplistic language of "safe" to the more technical-sounding "low risk" reveals how government officials conceptualized the general public in their risk management. They tended to think that the public was quite volatile (they were right about this, but in the wrong way), and likely to be irrationally worried about scientifically negligible risks. They also seemed to believe that more information would bring more trouble rather than more rational behavior. Administrators seemed to think that if the public were provided with detailed

Figure 1: candlelight demonstrators marching through the center of Seoul

information about American imported beef, and initiated a very complicated negotiation process regarding the immunologically, pathologically, and epidemiologically "dangerous" parts of the slaughtered animal, the situation would have worsened as people's outrage was fueled by the provided information, leading to the invention of more absurd stories. Government officials tended to believe (or perhaps wished to believe) that if they told the public a sweet spell of safety, people would let them do their job without bothering them to account for all the complexities of the case.

They could not have been more wrong on this. In hindsight, it is rather strange that they did not realize the possibility of a serious backlash against their patronizing attitude towards the public. There have been many cases in Europe and in the US wherein the public was not easily persuaded to a scientific viewpoint when presented with numerous facts about science (for example, when people believed that the earth was orbiting the sun).(5) However, That may be true of some well-established facts such as the one about the position of Sun in the solar system. In the case of BSE, although we do know the basic mechanism of its infectious path, we do not know many relevant facts about the disease, let alone any stable method to eliminate the risk of getting the disease by eating potentially contaminated beef. The facts that could be used to placate the public do not exist. Therefore, government officials tried to wave a magic wand to suppress real concerns.

To be fair, it is true that we should not alarm ourselves over every possible risk. If we did, we would have to stop doing anything at all. Even an appropriate measure taken against one particular risk may produce different, unintended risks. For instance, setting up an impeccable national security system could jeopardize civil liberties. Therefore, we have to evaluate our options carefully before making any decisions in our risk-governance.(6)

In order to thoroughly evaluate our options, we have to be informed as much as possible, as correctly as possible. Guaranteed access to objective information about relevant scientific consensus is the first condition for productive scientific communication. When there is no definite consensus on the issue, all available information should be made accessible to the public so that people can deliberate on their options and choose wisely among them.

In the case of the American beef crisis, there was a failure to provide relevant and reliable information as well as a lack of substantial relevant facts. Although scientific research about the prion mechanism is still not complete, scientific experts on prion and BSE had accumulated reliable enough knowledge to refute most of the safety claims made by government officials and their scientists.(7) In this sense, there was a failure to provide relevant scientific facts to the public, and mass media's commitment to present both sides of an issue equally did not improve the situation, since the safety claims were presented as though they were on equal scientific footing with the risk claims.(8)

On the other hand, there was intrinsic uncertainty as well. First, uncertainty derives from institutional vagueness; that is, who may be considered an "expert" qualified to make scientifically authoritative judgments on BSE-related questions? Scientists who sided with the official government position by making public statement about the safety of American beef included medical doctors, molecular biologists, and even nuclear physicists. There is no doubt that they are qualified scientists in their own fields, but they tend to think that their opinions (often prompted by their conservative political views) should be epistemologically respected simply on the basis that they are “scientists.” However, their epistemological privilege should not be indiscriminately applied to specialized areas such as the prion mechanism and BSE-related questions. When a person has a heart problem, they will consult a cardiologist, not an organic chemist. Likewise, it is not at all plausible that a physician is qualified to fix bugs in my computer program. Being a scientist in the general sense does not entitle a person to speak authoritatively on *any* scientific subject including, in this case, the risk involved in American beef; and yet, scientists in unrelated fields were given a voice in what was later called the American beef crisis. In this case, the selective ascription of epistemological authority to conflicting scientific claims was not transparent and the result was a lot of social confusion. The same pattern of behavior was repeated with respect to another social-scientific controversy on the environmental effects of the Four-River project.

The second kind of uncertainty is related to the complex nature of risk, that is, its dependency on interpretation by one discipline or another. The core of the problem is the fact that the risk of an event can be defined in more than one scientifically respectable way. This is because each scientific discipline has developed its own way of defining, estimating, and measuring risks according to their own theoretical and empirical concepts and tools, which are normally incommensurate, that is, only partially overlapping and not-entirely translatable into one another in Kuhn’s sense. Consequently, in the case of the American beef crisis, a different risk could have been calculated depending on which disciplinary expert did the calculating. Epidemiologists would have given one answer, while immunologists, another, as their evaluating methods are different (social statistics versus biochemical pathways). Public health experts might have come up with an entirely different probability, partly because their concern is more preventive than analytic. As the public was not used to this epistemological pluralism of scientific knowledge, many preferred to believe that there could be only one expert telling the truth and that all other scientists were simply lying. It is ironical to observe that people’s trust in scientists was compromised mainly because they believed in an unrealistic, monolithic ideal of scientific knowledge.(9)

In sum, the Korean government made two different mistakes in their risk management efforts during the American beef crisis. First, they incorrectly believed that the best way to manage an easily excitable public was to provide false information, asserting that there was scientific consensus assuring the safety of American imported beef, while there were in fact many uncertainties and real risks. Second, they falsely believed that providing technical probability assessment (that is, the probability of getting BSE from eating American imported beef was essentially negligible, while the exact value of the probability depends on the details of the questions and the models used) was sufficient to pacify the public. The first mistake shows the failure of transparency in their information distribution, and the second shows the failure of the deficit model.

3. Nuclear Power Plants and the Need of Risk-Governance

Nuclear power has been controversial at least since the Three-Mile Island disaster in 1979, was exacerbated by Chernobyl in 1989, and vividly reawakened by Fukushima in 2011. South Korea is not exempt from this controversy. At present, nuclear power accounts for about one third of the total electricity demand in South Korea, and the Korean government wants to enlarge nuclear energy production by building more nuclear power plants in the near future. Still, the current proportion of nuclear energy in South Korea is relatively small, mainly because nuclear energy is focused on the production of electricity.(10)

The so-called *nuclear power renaissance* is energetically advertised by the former government, especially the country’s first export of a nuclear power plant to the Arab Emirates. The government emphasizes the fact that South Korea is relatively well positioned in international competition for a number of forthcoming nuclear power plant contracts. This is due to that fact that the country has been expanding its nuclear energy industry (training people, accumulating construction expertise, building maintenance know-how, etc.), while the competitors (who were already more advanced in nuclear technology) made a "mistake" in trying to reduce their dependency on nuclear energy for last 20 years. The South Korean government and nuclear energy supporters do their best not to tell people that these countries might have had very good reasons to reject nuclear power. They have a strange logic, starting from what they perceive to be the indubitably true premise that nuclear energy is good. Add another empirical fact: "We are now getting ahead in nuclear power plant technology." The happy conclusion is that we are experiencing a nuclear energy renaissance!

Proponents of nuclear energy do cite some supporting evidence for their first premise. One example is the often-cited, economic advantage of nuclear energy and another is nuclear energy's benefits in the carbon-regulation age of climate change. Let us look at each and examine their claims more carefully.

Nuclear energy production is generally touted as economically efficient, meaning its production cost per unit of energy is lower than other energy sources such as coal or oil. It is true that the conventional calculation of energy production costs supports this conclusion. However, the conventional way of calculating production costs is faulty in many aspects. First, it does not take into account the fact that raw resources for nuclear power production, such as uranium, are highly concentrated in a few regions in the world. It is likely that the price fluctuation of raw resources would be more severe than more widely dispersed resources such as coal and oil. It is worth noting that renewable energy sources such as wind or sunlight are omnipresent. The uneven concentration of raw materials for nuclear power plants raises its security costs significantly. Although security costs are not always conspicuous under normal circumstances, that does not mean that the costs do not exist and we are safe to ignore them.

Secondly, and more seriously, the conventional calculation simply omits an incalculable cost altogether; that is, the maintenance costs of highly dangerous nuclear waste that will be around for at least for ten thousand years). Used nuclear fuel and contaminated materials necessarily emitted during nuclear energy production exude radiation at fatal level for many years to come. In order to prevent the hazardous consequences of radiation, an ultra-high level security system must be set up and maintained for many years as well. The cost for this is not included in the conventional calculation. The only part of the costs for dealing with nuclear wastes is the demolition cost of a nonoperational nuclear power plant, and even this is routinely and notoriously underestimated. If we properly calculate the real total cost for nuclear power production, taking into account its entire energy production cycle, nuclear energy looks disastrous even in purely economic terms.

There is a relatively new and fashionable claim that nuclear energy is clean and "green". This claim relies on another calculation that CO_2 emission during nuclear energy production is moderate compared to other ways of producing energy such as thermo power plants using coal or oil. Nuclear energy production, however, is not completely CO_2 free, even though the "green energy" labeling is likely to mislead people into believing otherwise. Given its relative advantage in contributing to our international effort to reduce CO_2 emissions as quickly as possible to slow the rate of climate change, some countries are seriously considering using existing nuclear power production facilities as much as possible.

It is not however that apart from notable exceptions such as France and China, most countries are trying to use up their remaining plants as a sort of bridging technology that allows them to go to the fully green energy stage, perhaps envisioned in Rifkin's recent book, *The Third Industrial Revolution*.[11] The reason is obvious: nobody would want to use potentially disastrous tools to prevent another potentially disastrous event in the long run.

A more sensible course of action would be to find a more sustainable solution to the problem. Currently, the best candidate for a satisfactory solution is recycled energy such as sunlight, sunheat, wind, etc. There are many difficulties to overcome with regard to developing the use of these resources, including lowering the energy production costs, developing an efficient storage system, building a smart grid network, renovating the energy production-consumption pattern, and so on. International coordination of energy consumption is also crucial to obtaining a stable energy regime on earth.[12] These are daunting tasks, but it is not clear whether the problems relating to nuclear energy production are any less daunting. If we recall just the astronomical costs to just *keep safe* the nuclear waste for millions years and the technical difficulties involving such task, we can realize the nuclear energy production is full of unsavory surprise.

Finally, we have to realize that nuclear energy production tends to foster an authoritarian governance structure. This is because the very existence of nuclear power plants poses a number of high-risk security issues. There is the genuine possibility of nuclear terrorism and other misuse of radioactive materials. That is why all the nuclear power plants in the world are under constant surveillance. To maintain this high level surveillance for many, many years is a truly unattainable goal, especially since it has to be done no matter what political turmoil and economic crises might occur in the region. Considering all this, nuclear energy does not look so clean or green anymore.

I do not appeal to environmentalism or any other potentially controversial claims about how to organize our lives and society. I want to highlight the fact that, without any help from any ideal-sounding claims, we can rationally judge that nuclear power plants must disappear as soon as possible. Even the very narrow economic consideration, with proper cost-benefit analysis, supports this view.

While the need to abolish nuclear energy is strong, that does not mean that nuclear power plants can simply be abolished now and forever. There has to be a rather long (hopefully, not too long) transition period, bridging our current mode of energy production to a better, more sustainable energy production system. During the transition period, we need an intelligent risk-governance reinforced by transparent risk-communication. We should never try to mislead the public, indicating that they can remain in this unsustainable way of energy production and consumption. We should start building institutions that will allow us to get through the transition as smoothly as possible. Simultaneously, we must control the intrinsic risk associated with nuclear power plants with a more open attitude, meaning willing to take a more 'inclusive' protocols in relevant decision-making. Complex systems like nuclear power plants are not likely to be immune from accidents. Better communication with residents around plant sites, coupled with a public guarantee to access maintenance information, will help build the trust among people that is crucial to support the temporary and safe working of the plants.

4. Concluding Remarks: Cost-Benefit Analysis and the Precautionary Principle

The two failed cases of risk management discussed in this paper illustrate the need for an extended concept of risk-governance; that is, a more participatory, transparent structure of risk management that gets interest groups involved and reflects citizens' opinions on governing the intrinsic risks associated with complex technological systems such as international epidemic control or nuclear power production.[13]

Still, there is another deeper aspect of these two failures. They show the conceptual limitation of cost-benefit analysis itself, and the need for properly understanding the precautionary principle. Cost-benefit analysis is strongly favored by government officials because of its intuitive justifiability. If we have a potential risk to deal with, let us calculate its expected cost and benefit, and compare them to arrive at an objective decision. That sounds nice and clear, but the appearance of straightforward calculation actually hides a certain ethical and institutional assumption.

For instance, the usual cost-benefit calculation, applied to our efforts to slow down global warming, gives us a negative answer, mainly because without suitable institutions such as a universal carbon tax, the benefit private industry can get from our actions is not that great and the cost appears larger. Costs and benefits can be calculated only in a given institutional setting, and if we decide to change the setting for political or moral reasons, the results of an objective cost-benefit analysis vary accordingly. In this sense, the apparently value-free calculations involved in the standard economic calculation actually rest on huge assumptions about what constitutes an ethical way to organize our society and individual lives. If we collectively deliberate, applying all relevant information, and come up with a reasonable plan to change our way of governing the intrinsic risks of complex technological systems, the economic conclusions may be appropriately streamlined to suit our vision. Economic rationality is important in our everyday risk management, but we have to decide how to set up a risk-governance structure before starting the routine work of managing risks. And that is the legitimate way of implementing the precautionary principle, not simply foolhardily following the verdict from cost-benefit calculations.

NOTE

(1) An earlier version of this paper was presented at the Fourth East Asian Humanities Conference held at Waseda University from December 7-10, 2012. I am grateful for the comments and discussions generously offered by the participants. The editorial advice was also quite helpful. I appreciate it.

(2) For further discussion of this issue, see Hacking 1995. Notice that Hacking does not side entirely with ontological relativism. He recognizes the clear physical/biological aspects of severe mental disease, and he is known for his strong realistic position on scientific entities, which he believes we can manipulate to produce observable effects. See Hacking 2000 and 2002 on this.

(3) For a classical discussion of the distinction between risk and uncertainty, especially in the context of economic decision-making, see Knight 1984. A more broad examination of the distinction, including questioning the legitimacy of the distinction itself in actual situations, can be found in Posner 2005 and Sunstein 2007.

(4) For a detailed discussion of the role the international risk-governance regime plays in the case of imported beef in South Korea, see Ha 2011. A more internal analysis of the case can be found in Seong and Jeong 2008.

(5) See Gregory and Miller 1998 for a general discussion on the problem of the "deficit model."

(6) See Sunstein 2005 for a comprehensive discussion of tackling low-probability risk cases. I do think that Sunstein is too harsh on the regulatory effectiveness of the "Precautionary" principle, but nevertheless, his warning on the misuse of the principle is worth considering.

(7) Professor Hee Jong Woo, an expert in prion and BSE as well as an influential critic of the government's position during the American-Beef case, had strongly emphasized this point in many interviews and public talks.

(8) This common tradition of "fair" reporting started as an effort to be as unbiased as possible in dealing with highly controversial political disputes. To see how harmful this seemingly innocuous custom can be when it comes to scientific reporting, see Nelkin's classic analysis (Nelkin 1995) and Oreskes and Conway's revealing examination of a number of cases (Oreskes and Conway 2010).

(9) Similar situations developed in America relating to global warming and climate change issues. See Dessler and Parson 2006, and Oreskes and Conway 2010. For more international discussions of the issues, see Bolin 2007 and Giddens 2009.

(10) For a general survey of nuclear power plants and policy, see Kim 2011.

(11) Rifkin 2011.

(12) Dryzek 1997.

(13) I studied the need to expand risk considerations in Yi 2005, 2010, and ways to increase public participation in technological planning in Yi 2011a.

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